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FACTORS INFLUENCING THE PROCESS OF SOWING SEEDS OF GRAIN CROPS AND MINERAL FERTILIZERS INTRODUCTION

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Abstract

Sowing is one of the most important operations of technology of crop cultivation in which the embedding of seeds into the soil and conditions for germination are created.

The cultivation of crops planting is responsible operation. Future harvest is largely determined by the chosen method of sowing, seeding rate, seeding depth according to the specific soil and climatic conditions [1,2]. Methods for seeding are selected not only on the biological requirements of the crop to the area of nutrition, lighting, moisture supply, but also with a view to preserving and increasing soil fertility [1,2].

Keywords*:* crop, model, seal seed, fertilizers, seeding machine.

Introduction

Many researchers [3, 4] noted that if the plants are placed along the rows rarely, even the most luxuriant development of each of them cannot provide complete coverage of the area of the soil and the use of the entire flow of radiant energy, nutrients and moisture. Reduced yield per unit of area in this case is due to the fact that part of the energy which could be used for photosynthesis lost useless. On the other hand, with a strong thickening phenomena stronger mutual shading of individual plants occurs competition for moisture and nutrients is growing, often plant diseases are enhanced, which also reduces the productivity of the plant and ultimately, crop yields.

With all the variety of drills designs for sowing seeds and tools for the subsurface mineral fertilizers they all have the same set of similar technical facilities, the most important of which are the following: a hopper (container), seed and fertilizer metering and distribution device (sowing machine) seeding tubes, working parts for seeding and fertilizing the soil. Hopper is designed to hold the required amount of seed for sowing and fertilizers (materials). Moreover, they contain not only the supply of the necessary material, but also provide the required flow of material through the openings ending to the metering devices. Planting unit provides a selection and dosing of materials from the hopper, as well as their distribution by delivery tube. Further seed mineral tubes transport relevant portions of the materials to the working bodies for their subsurface distribution: openers (central shovel) - for laying the seeds into the soil; scuffle knife - for subsurface mineral fertilizers.

Research methods

For the synthesis of a control system by sowing seeds and mineral fertilizers we present technological process as a series of successive operations, figure 1: supply of the material in the sowing machine; dispensing material (seeds and fertilizers); transporting the material through the seeding tubes to the working body; subsurface distribution of the material. Where input actions are vectors of feed materials (Qc (t) and Qm (t)), and the corresponding control vector Uc (t) and Um (t). Values Qc (t) and Qm (t) are characterized by the parameters of the receiving bins (boxes) for the seed and the fertilizers, respectively.

The output flows $Q_{св}(t)$ and $Q_{мв}(t)$ are strongly influenced by the parameters of sowing windows of the bins (boxes), which are fed through the material. On the motion of the material in the box the size of the hole, the particle size, the angles of the outer and inner tensions height of the arch material, the shape of the bottom drawer, and so on affect. In addition, an important issue is the study of the flowing process of the materials out of the boxes through the window under the influence of the gravity or force.

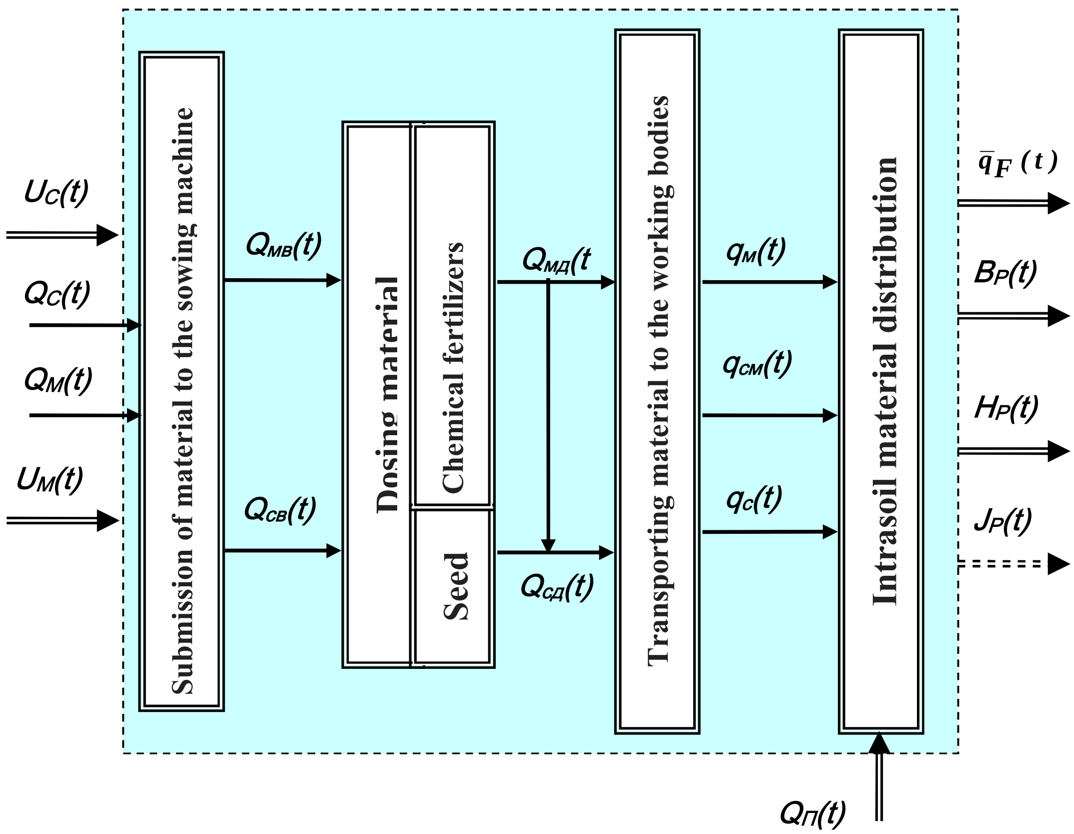

Figure 1- Functional model of seeding process and mineral fertilizers introduction

1) Подача материала на выс. Апп. – delivery of the material to the sowing device. 2) Dosing the material 3) Seeds. Mineral fertilizers 4) Transporting the material to the working organs. 5) Intrasoil distribution of the material

The analysis work on the dosing of seeds and fertilizer shows that providing uniform dosing materials (Qcd (t) and Qmd (t)) is a complex scientific task. The reason is that this process is influenced by many random effects: type of dosing material and its physical and mechanical properties, the construction of the dispenser, the dispensing opening area, etc.

Formed input streams of feed materials are sent to the further sowing apparatuses, and in the output a set dose of materials is received Qcd (t) and Qmd (t). Additional parameters for the constancy of these values are: changing the speed of the machine, the gear ratio drive mechanisms, type of sowing machine, etc.

For actual doses of seed and fertilizer and seed $q_c(t)$ and fertilizer $q_M(t)$ at the same time $q_{cM}(t)$ the process of transporting materials to the working bodies is performed. Seeding tubes can be considered as transport unit which does not change the flow of materials, but it makes the directing of the flow of the distribution device in the working bodies. Except structural and technological parameters of the seeding tubes the process of transportation of materials is strongly influenced by the aerodynamic properties of the particles, especially on machines with pneumatic systems. It is important to note to ensure uniform seeding (application) of the materials it is necessary the speed of the movement of materials on the stage under the consideration to remain constant.

The final step of the considered model is the distribution of subsurface materials, which depends on the methods of their incorporation, designs and types of working bodies, etc. This requires keeping the state of the soil environment Qp (t).

The main output indicators of the functionality of the model are: the required standards (dose) of seeding material $\bar{q}_F(t)$ ($\bar{q}_C(t)$, $\bar{q}_N(t)$, $\bar{q}_P(t)$, $\bar{q}_K(t)$, $\bar{q}_M(t)$); working width sieving; uneven distribution of material across the width and length of the screening materials. These and other parameters, which are determined by the implementation of a particular technological process must meet the agronomic requirements. Thus, adaptation processes of seed and fertilizer is achieved under the following conditions:

- The rules for the distribution of seed and doses of mineral fertilizers in the direction of the unit’s movement x:

$$\begin{cases} \bar{q}_C(x) = q_{(A)C}(x) - q_C(x) \cong \eta_C; \\ \bar{q}_N(x) = q_{(A)N}(x) - q_N(x) \cong \eta_N; \\ \bar{q}_P(x) = q_{(A)P}(x) - q_P(x) \cong \eta_P; \\ \bar{q}_K(x) = q_{(A)K}(x) - q_K(x) \cong \eta_K; \\ \bar{q}_M(x) = q_{(A)M}(x) - q_{(M)}(x) \cong \eta_M. \end{cases} \quad (1)$$

- The rules for the distribution of seed and doses of mineral fertilizers on the width of the unit y:

$$\begin{cases} \bar{q}_C(y) = q_{(A)C}(y) - q_C(y) \cong \varepsilon_C; \\ \bar{q}_N(y) = q_{(A)N}(y) - q_N(y) \cong \varepsilon_N; \\ \bar{q}_P(y) = q_{(A)P}(y) - q_P(y) \cong \varepsilon_P; \\ \bar{q}_K(y) = q_{(A)K}(y) - q_K(y) \cong \varepsilon_K; \\ \bar{q}_M(y) = q_{(A)M}(y) - q_{(M)}(y) \cong \varepsilon_M, \end{cases} \tag{2}$$

Where, $q_{(A)C}(t)$, $q_{(A)N}(t)$, $q_{(A)P}(t)$, $q_{(A)K}(t)$, $q_{(A)M}(t)$ - agro technically necessary norms of seed sowing (***C***), nitrogen doses (***N***), phosphorus (***P***), potassium (***K***) components and microelements (***M***);

$q_C(t)$, $q_N(t)$, $q_P(t)$, $q_K(t)$, $q_M(t)$ - actual norms of sowing seeds (***C***), nitrogen doses (***N***), phosphorus (***P***), potassium (***K***) components and microelements (***M***);

$\eta_{C(N,P,K,M)}$, и $\varepsilon_{C(N,P,K,M)}$ - marginal deviations of seeding rates of seeds and making appropriate doses of fertilizer components, respectively, in the direction of movement and the width of the unit.

Similarly, conditions for implementation and other output parameters of the technological process can be defined.

Studies of seed and fertilizer in the conditions of Northern Kazakhstan have shown that the provision of the required quality of operations can be achieved by choice of rational values of the factors affecting the output indicators.

The results of the investigations

1).Taking into account the complexity of the description of processes of seed and mineral fertilizers using only analytical dependences let's do their functional analysis. Considering that the study process deviations from the established values of the variables are fairly small, but their function changes smoothly let's use the known method of linearization of dynamic systems. As the object of study, let's consider filing process (movement) material (seeds and fertilizers) from the bins (boxes) to the working bodies for seeding and subsurface mineral fertilizers introduction (Figure 1).

In general, the input streams are functions required standards (doses) of introducing materials ($q_{F(j)}$), depending on the working width (B_p) and the speed of the unit (V_M):

$$Q_{(j)} = 10^{-4} \cdot q_{F(j)} \cdot B_p \cdot V_M . \tag{3}$$

With regard to the process under consideration the value $q_{F(j)}$ is determined by the physical and mechanical properties of materials ($\gamma_{(j)}$), the parameters of the metering device (b- wide dosing window -h opening height of the metering valve), the gear ratio of the drive mechanism ($i_{МП}$) and the type of sowing device (n):

$$Q_{(j)} = 10^3 \frac{V_M \cdot i_{M\Pi}}{n+1} b \cdot h \cdot \gamma_{(j)}. \qquad (4)$$

Expanding the relationship (4) in a Taylor series with respect to a zero point, let's define the transfer function links the processes of the described material flow from the hopper to the seeding tubes:

$$F(Q_{(j)}, V_M, \gamma) = F(Q^0_{(j)}, V^0_M, \gamma^0) + \frac{\partial F}{\partial V_M}\Delta Q + \frac{\partial F}{\partial \gamma}\Delta\gamma + R, \qquad (5)$$

where $Q_{(j)} = Q^0_{(j)} + \Delta Q_{(j)}$; $V_M = V^0_M + \Delta V_M$; $\gamma = \gamma^0 + \Delta\gamma$; R -the remaining term of the series.

If we neglect the remaining term of series of increment of the function $\Delta F(Q_{(j)}, V_M, \gamma)$ is defined as

$$\Delta F(Q_{(j)}, V_M, \gamma) = F(Q_{(j)}, V_M, \gamma) - F(Q^0_{(j)}, V^0_M, \gamma^0) = 0. \qquad (6)$$

Considering that $\frac{\partial F}{\partial Q_{(j)}} = 1$; $\frac{\partial F}{\partial V_M} = \frac{\partial Q_{(j)}}{\partial V_M}$; $\frac{\partial F}{\partial \gamma} = \frac{\partial Q_{(j)}}{\partial V\gamma}$, then we get

$$\Delta Q = -\left(\frac{\partial Q_{(j)}}{\partial V_M}\Delta V_M + \frac{\partial Q_{(j)}}{\partial \gamma}\Delta\gamma\right). \qquad (7)$$

From the expression (7) it should be that, if $\Delta V_M = 0$, then

$$\Delta Q = -\frac{\partial Q_{(j)}}{\partial \gamma}\Delta\gamma, \qquad (8)$$

But if $\Delta\gamma = 0$, then

$$\Delta Q = -\frac{\partial Q_{(j)}}{\partial V_M}\Delta V_M. \qquad (9)$$

Applying the Laplace transform to equation (7) ... (9), let's define the transfer function of the dispenser:

$$W_Q(p) = -\left(\frac{\partial Q_{(j)}}{\partial V_M} + \frac{\partial Q_{(j)}}{\partial \gamma}\right) = K_1 + K_2. \qquad (10)$$

Thus, the dispenser can be viewed as a system consisting of two parallel-connected units, i.e. how $K_Q = K_1 + K_2$

Differentiating (10), and considering that; $K_1 = \frac{\partial Q_{(j)}}{\partial V_M}$; $K_2 = \frac{\partial Q_{(j)}}{\partial \gamma}$ We obtain:

$$K_1 = 10^3 \frac{i_{МП}}{n+1} b \cdot h \cdot \gamma ;\ K_2 = 10^3 \frac{V_M \cdot i_{МП}}{n+1} b \cdot h . \qquad (11)$$

Analysis of the formulas (11) shows that the coefficients are the constants. Then, according to (10) the transfer function of the dispenser can be written as

$$W_Q(p) = 10^3 \frac{i_{МП}}{n+1} b \cdot h \cdot (\gamma + V_M). \qquad (11)$$

The sensitivity of the transfer function (11) is influenced by the type of sowing machine, its design and technological parameters, modes of operation of the dispenser, as well as material properties.

Seed - or seeding tubes create directional flow of material from the dispenser to the sowing of the working body of the dispensing device. It can be viewed as a time-lag element with a transfer function:

$$W_{T(j)}(p) = q_{(j)} = exp(-\tau \cdot p). \qquad (12)$$

If we consider that the time lag $\tau = L_T / V_T$, the dependence (12) can be represented as

$$W_{\bar{q}}(p) = exp(-\frac{L_T}{V_T} \cdot p), \qquad (13)$$

where L_T - The length of the seed - or seeding tube; V_T - Speed of the material movement.

Upon validation of the parameters of the seed or seeding tube or changing its position, it is possible to select the position and dimensions of the zone of making material so as to provide the required output characteristics.

References

1. Aduov M.A. Scientific and technological bases of creation of means of sowing the seeds of grain and mineral fertilizers (on the sample of the northern zone of Kazakhstan): theses for doctor of techn.sci.,Almaty, 2008.- p.224

2 Nukusheva S.A. Substantiation of technological and design parameters for the opener dispersing subsoil sowing of crops: theses for cand.tehn.sci. Almaty,2010.p.32

3. Aduov M.A., Kapov S.N., Nukusheva S.A. Model of soil environment as the object of machining. Journal of Science of the Kazakh National Agrarian University **"Research results"-Almaty.№3,2014**

4. Aduov M.A., Matyushkov M.I., Nukusheva S.A. Analysis of the drills and seeding systems for resource-saving technologies of cultivation of grain crops in the conditions of Northern Kazakhstan. Materials of republican scientific-theoretical conference "Seifullin readings 11", Astana. 2015.p.31-33.

Резюме

При всем многообразии конструкций сеялок для посева семян и орудий для внутрипочвенного внесения минеральных удобрений все они имеют одинаковый набор сходных технических средств, основные из которых следующие: бункер (емкость) для семян и удобрений, дозирующее и распределительное устройство (высевающий аппарат), семятукопроводы, рабочие органы для заделки семян и внесения удобрений в почву.

Окончательным этапом рассматриваемой модели является внутрипочвенное распределение материалов, которое зависит от способов их заделки, конструкции и типов рабочих органов и т.д.

Установлено, что при обоснованных параметрах семя - или туконаправителя, изменяя его положение, можно выбрать координаты и размеры зоны внесения материалов таким образом, чтобы обеспечить требуемые выходные характеристики.

Түйін

Тұқым себетін сепкіштер мен минералдық тыңайтқыш енгізетін құралдардың құрылыстары әртүрлі болғанмен, олар құрамы ұқсас негізгі техникалық бөліктерден тұрады: тұқым және тыңайтқыш жәшігі (сыйымдылық), мөлшерлеуші және таратушы құрылғы (сепкіш аппарат), тұқым және тыңайтқыш өткізгіштер, тұқым және тыңайтқышты топырақ ішіне сіңіретін жұмысшы құрылғылар.

Қарастырылып отырған үрдістің соңғы кезеңі топырақ ішінде материалдарды тарату болады, ол кезеңнің сапалық көрсеткіштері материалдарды топырақ ішіне енгізу әдісіне, жұмысшы құрылғының түрі мен құрылысына және т. б. тәуелді.

Құрылымдық парметрлері негізделген тұқым және тыңайтқыш таратқыштардың жағдайын өзгерте отырып, қажетті шықпа сипаттамысын қамтамасыз ететін материал енгізетін аймақ өлшемдері мен координаталарын таңдап алуға болады.